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Reduction versus abrupt cessation in smokers who want to quit (Review)

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TABLE OF CONTENTS

[Intervention Review]

Reduction versus abrupt cessation in smokers who want to quit

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ABSTRACT

Background

The standard way to stop smoking is to quit abruptly on a designated quit day. A number of smokers have tried unsuccessfully to quit this way. Reducing smoking before quitting could be an alternative approach to cessation. Before this method is adopted it is important to determine whether it is at least as successful as abrupt quitting.

Objectives

1. To compare the success of reducing smoking to quit and abrupt quitting interventions. 2. To compare adverse events between arms in studies that used pharmacotherapy to aid reduction.

Search strategy

We searched the Cochrane Tobacco Addiction Review Group specialised register, MEDLINE, EMBASE and PsycInfo for topic specific terms combined with terms used to identify trials of tobacco addiction interventions. We also searched reference lists of relevant papers and contacted authors of ongoing trials. Date of most recent search: November 2009.

Selection criteria

We included randomized controlled trials (RCTs) that recruited adults who wanted to quit smoking. Studies included at least one condition which instructed participants to reduce their smoking and then quit and one condition which instructed participants to quit abruptly.

Data collection and analysis

The outcome measure was abstinence from smoking after at least six months follow-up. We pooled the included trials using a Mantel-Haenszel fixed-effect model. Trials were split for two sub-group analyses: pharmacotherapy vs no pharmacotherapy, self help therapy vs behavioural support. Adverse events were summarised as a narrative. It was not possible to compare them quantitatively as there was variation in the nature and depth of reporting across studies.

Main results

Ten studies were relevant for inclusion, with a total of 3760 participants included in the meta-analysis. Three of these studies used pharmacotherapy as part of the interventions. Five studies included behavioural support in the intervention, four included self-help therapy, and the remaining study had arms which included behavioural support and arms which included self-help therapy. Neither reduction or abrupt quitting had superior abstinence rates when all the studies were combined in the main analysis (RR= 0.94, 95% CI= 0.79 to 1.13), whether pharmacotherapy was used (RR= 0.87, 95% CI= 0.65 to 1.22), or not (RR= 0.97, 95% CI= 0.78 to 1.21), whether studies included behavioural support (RR= 0.87, 95% CI= 0.64 to 1.17) or self-help therapy (RR= 0.98, 95% CI= 0.78 to1.23). We were unable to draw conclusions about the difference in adverse events between interventions, however recent studies suggest that pre-quit NRT does not increase adverse events.

Authors' conclusions

Reducing cigarettes smoked before quit day and quitting abruptly, with no prior reduction, produced comparable quit rates, therefore patients can be given the choice to quit in either of these ways. Reduction interventions can be carried out using self-help materials or aided by behavioural support, and can be carried out with the aid of pre-quit NRT. Further research needs to investigate which method of reduction before quitting is the most effective, and which categories of smokers benefit the most from each method, to inform future policy and intervention development.

PLAIN LANGUAGE SUMMARY

Comparing reducing smoking to quit with abrupt quitting.

The standard way to quit smoking is to smoke as normal until a quit day at which point the smoker stops using all cigarettes. Most smokers who try to quit end up relapsing, therefore there are a number of people who have tried to quit abruptly in the past without success, and are disillusioned with this approach. An alternative way to give up could be to reduce the amount of cigarettes smoked before going on to quit completely. There is evidence to suggest that reducing smoking before quitting would be popular with smokers. This means that offering this approach to quitting could encourage more smokers to give up, however before offering this approach it is important to ensure it is at least as successful as abrupt quitting. This is because given a choice smokers who would otherwise have quit abruptly may choose to reduce first instead. If reduction isn't as effective, smokers who choose that method will be at a disadvantage. The aim of this review was to compare quit rates in reduction to quit and abrupt quitting interventions to see if reducing to quit is at least as successful as abrupt quitting. Ten studies were found which compared reducing smoking before quitting with abrupt quitting. Pooled results found that neither reducing or abrupt quitting produced superior quit rates. This was true whether nicotine replacement therapy was used as part of the intervention or not, and whether participants were offered self-help materials or behavioural support. These results suggest that smokers should be given a choice of quitting methods, either reducing smoking before quitting or abrupt quitting, however, to inform the development of new interventions more research is needed into which method of reducing smoking is the most effective.

BACKGROUND

Description of the condition

Tobacco use is the largest preventable cause of death in the world, as a risk factor for six of the eight leading causes of death. A survey of a sample of 893 English smokers (Jarvis 2002) found that most were disenchanted with smoking and, if they were given their time again, they would not have started smoking in the first place. Most of these smokers expected to be quit within a few years, but historical data on quit rates suggest this is extremely unlikely because most people who try to quit relapse quickly (Hunt 1973). The authors interpreted this as a delusion gap between expectations and likely reality. Such a gap means we need to find new ways to encourage smokers, most of whom have tried to quit repeatedly, to keep on trying. Finding new ways to quit would be helpful to this endeavour.

Description of the intervention

The standard way to stop smoking is to quit abruptly. This means that a person smokes as normal until a designated quit day, from which point forward they try to abstain and avoid any smoking whatsoever.

An alternative method is to quit gradually. Such gradual reduction methods, when used as a means of achieving cessation, typically have a quit day as in abrupt cessation. The key difference is that smokers aim to reduce smoking prior to this day. Some researchers have investigated the relative efficacy of different methods of reducing smoking on the likelihood of achieving reduction and of subsequently achieving abstinence, but this is not the focus of this review. All such different methods are pooled here.

How the intervention might work

There are a number of ways that reducing the amount of cigarettes smoked prior to total abstinence might help a smoker give up completely. The first of these is a principle of psychopathology, which suggests that, as the dose of nicotine received by the individual each day is reduced, drug dependence and therefore craving is reduced in response. Another is 'shaping', a conditioning procedure, whereby making successive approximations of the target behaviour (gradually cutting down the number of cigarettes smoked) the desired behaviour (abstinence) is eventually achieved. The third is the cognitive psychology principle that completing a step toward a goal (reducing smoking) increases self efficacy, which increases the likelihood that the goal (abstinence) will be achieved. The fourth is the classical and operant conditioning principle that reducing the frequency of a behaviour decreases the association with environmental cues, which in turn weakens the urge to partake in that behaviour when those cues are present. Finally reducing provides a goal which is more in-line with the smokers current behaviour than complete abstinence and therefore appears more achievable. However, the standard assumption of smoking cessation treatment is that cessation begins on a quit day and that cutting down prior to quitting is not advised. This is based on nicotine addiction theory, which claims that the user has impaired control over their drug use, and that it should therefore be difficult for them to control their usage in any way, e.g. by reducing. It also assumes that with reduction each remaining cigarette will become more rewarding and harder to give up, and that the smoker will suffer a loss of motivation before attaining total abstinence. However medication to reduce withdrawal, such as nicotine replacement therapy (NRT), could be used to counteract this effect, and has successfully been used to do so in smokers who are not yet ready to quit (McRobbie 2006; Wang 2008). Wang et al conducted an assessment report which examined the effectiveness and cost- effectiveness of NRT alongside 'cut down to quit' (CDTQ) smoking in people who were either unwilling or unable to quit (Wang 2008). The approach was found to be both effective, and cost effective, although abstinence rates were not as high as those documented in abrupt quitting regimes. Studies which utilise the CDTQ approach, and therefore people who are unable or unwilling to quit, have already been included in the Cochrane review of harm reduction (Stead 2007). Our review will focus only on those smokers who want to quit. Surveys have been carried out across England and Wales (West 2001) and the UK, US, Canada and Australia (Cheong 2007), investigating the success of quit attempts when smokers reduce cigarettes smoked with an aim to quitting completely. Both of these observational studies found that abrupt quitting was almost twice as successful as quitting gradually in those sampled. However participants in these studies were from the general population and hadn't used a particular service or intervention. They could potentially have used a wide range of gradual quitting techniques, ranging from no structure, no reduction goals and no set quit day to highly structured, with set reduction goals and a target quit day to work toward, which may have influenced success rates.

Although British (NICE 2008) and American (Fiore 2008) national guidelines for smoking cessation services do not recommend reducing smoking before quitting, both conclude that further research is needed into whether it could be used as a successful intervention to help those who have tried unsuccessfully to quit in the past. The US Medicines Regulator, and some other pharmaceutical regulators, have not approved the use of NRT for smokers who wish to cut down the amount they smoke without wanting to quit. However, the Medicines and Healthcare Regulatory Authority (MHRA) in the UK and other medicines regulators have licensed the use of NRT for this purpose. UK guidelines suggest that, until further evidence is available, this strategy should only be used in properly designed and conducted research studies. New Zealand's smoking cessation guidelines (NZ MoH 2007) mention cutting down cigarettes smoked, but as a strategy that should only be implemented in those unwilling to quit. Cutting down is therefore a strategy that is either not recommended by national guidelines or is only recommended for smokers not ready to stop.

Why it is important to do this review

Without help, most people who try to stop smoking relapse within one week and only 4% sustain abstinence for one year (Hughes 2004). The UK is the only country with a truly nationwide network of smoking cessation clinics, although a growing number of countries are developing a variety of free or subsidised services to help smokers to quit. Although these clinics, substantially increase rates of abstinence, most people who try to stop smoking will fail to do so. For example, the evaluation of the UK National Health Service (NHS) specialist stop smoking services showed that 15% of patients achieved abstinence for a whole year (Ferguson 2005). Thus, while treatment substantially improves the number who achieve abstinence, a return to smoking is the norm for the majority, whatever method of stopping is used. Consequently there is a cadre of patients who have been through treatment services

a number of times. Smoking cessation services currently recommend abrupt cessation for all quit attempts (first or repeated), whereas alternative methods might be more successful or at least give renewed hope and encourage cessation in those who have given this up as impossible. Gradual cessation could offer a new way to quit for those who have failed previously, but it can only be recommended by therapists if it is an effective strategy for cessation.

There is evidence to suggest that some people feel that reducing the number of cigarettes they smoke is an important first step towards quitting completely. In the English Smoking Toolkit Study, 40% of quit attempts included cutting down first (West 2006). A survey of respondents to an advertisement for people interested in cessation found that 66% planned to stop by cutting down gradually, while 13% planned to stop abruptly. In a survey of people responding to an advertisement for those planning to reduce smoking, 57% planned to reduce and then stop (Hughes 2006). A survey of US daily smokers showed that in their most recent quit attempt 35% tried to stop gradually while 65% tried to stop abruptly (Hughes 2007). Those who chose gradual cessation were as motivated to stop and as confident of success as those who used abrupt cessation. A random sample of US smokers showed that nearly half of smokers planning to quit would choose reduction over abrupt cessation (Shiffman 2007). There was little interest among these smokers in reduction as an end in itself, only as a means to abstinence. Reducing the number of cigarettes smoked as a means to giving up smoking may prove to be a popular approach, and may draw people into treatment services. Given behavioural support and pharmacotherapy increase the likelihood of achieving abstinence (Lancaster 2005; Stead 2005; Stead 2008) this would have public health benefits.

OBJECTIVES

- To compare the success of smoking cessation interventions that instruct the smoker to reduce the amount they smoke before quitting with interventions that instruct the smoker to stop smoking abruptly.
- To compare adverse events by arm, stratified by whether they use pharmacotherapy.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled trials. We included a trial where allocation to treatment arms was cluster randomized, and carried out a sensitivity analysis to adjust for this clustering. To meet the second objective we examined adverse events only in those trials which had a reduction arm utilising pre-quit pharmacotherapy and an abrupt quitting arm that did not utilise pre-quit pharmacotherapy.

Types of participants

Cigarette smokers of any age who intended to stop smoking soon. Participants demonstrated their commitment to quitting by enrolling in a smoking cessation programme. Trials that enrolled smokers who did not intend to quit soon were excluded, as they are covered by the Cochrane review of harm reduction (Stead 2007).

Types of interventions

We compared any instruction to participants to reduce the amount of cigarettes smoked before quitting, with any instruction to stop smoking abruptly without prior reduction. We did not include trials with arms where participants spontaneously reduced before quitting without being advised to do so, versus arms where participants stopped abruptly.

Interventions included anything from no behavioural support to extensive behavioural support, but studies were excluded if behavioural support differed substantially in type or duration between arms. Behavioural support pre- and post-quit could vary between the reduction and abrupt quit arms as long as overall contact was roughly equal. Trials could also include concomitant pharmacotherapy to support cessation, as long as it was equivalent in all trial arms after cessation. Pharmacotherapy used prior to quit day could vary as a necessary component of the intervention i.e. to support smoking reduction.

Types of outcome measures

Primary outcomes

The primary outcome was abstinence from smoking at least six months after the quit day. We excluded trials with a follow up of less than six months.

In trials with more than one measure of abstinence, we preferred the measure with the strictest criteria. We used prolonged or continuous abstinence over point prevalence abstinence, and preferred biochemically validated abstinence, such as by exhaled carbon monoxide, over self-report.

Secondary outcomes

The secondary outcome was the type and number of adverse events recorded.

Search methods for identification of studies

We searched the Cochrane Tobacco Addiction Review Group specialised register, which has been developed from electronic searches of MEDLINE, EMBASE and PsycINFO, together with handsearching of specialist journals, conference proceedings and reference lists of previous trials and overviews. We also searched MEDLINE, EMBASE and PsycINFO for possible trials to include in the review, searched the reference lists of relevant trials, and where necessary contacted the authors of ongoing trials.

We searched MEDLINE (Ovid, 1966 to 5th November 2009), EMBASE (Ovid, 1980 to 2009 week 44) and PsycINFO (Ovid, 1967 to 23rd November 2009) using the following topic-specific terms:

- cold turkey.mp
- (schedul* adj3 smok*).mp
- (cut* down or cut-down).mp
- (({Gradual* or abrupt*}) adj3 (reduction or reduce* or quit* or stop* or abstin* or abstain* or cessat*)).mp
- fading.mp
- taper*.mp
- (controlled adj smoking).mp

[mp=title, original title, abstract, name of substance word, subject heading word]

We combined these with the terms used for the regular searches of MEDLINE, EMBASE and PsycINFO to identify trials of tobacco addiction interventions for the Tobacco Addiction Review Group specialised register. Full strategies are shown in the Appendices. We also searched the specialised register in November 2009 using the following terms: Cold turkey or schedul* or Cut* down or cut-down or Gradual* or abrupt* or fading or reduction or reduce* or taper* or controlled smoking.

Data collection and analysis

Selection of studies

One author checked the titles and abstracts of studies generated by the search strategy for relevance, and obtained copies of papers reporting relevant trials. Two authors then independently assessed the reduced trials list for inclusion in the review. Any disagreements were resolved through discussion with the remaining review author. We based eligibility decisions on the following questions:

1. Is the study described as randomized or quasi- randomized?
2. Were the participants cigarette smokers who wanted to quit?
3. Did the study include at least two groups, i.e. one group advised to reduce their smoking before quitting and one advised to quit abruptly on quit day?
4. If the intervention includes behavioural support with or without pharmacotherapy, is overall contact for behavioural support and post-quit pharmacotherapy similar between both groups?
5. Is the intervention an instruction to reduce the number of cigarettes smoked, rather than an instruction to reduce harm, e.g. smoking cigarettes with lower levels of nicotine?
6. Does the study report smoking abstinence at least six month after the quit date?

If the answer to any of the above questions was 'No' then the trial was not included in the review.

Data extraction and management

For each included trial one author extracted the data and another author checked them. The only included paper published in Spanish was translated into English (Roales-Nieto 1992). We extracted the following information for inclusion in the Characteristics of included studies table:

Methods:

- The design of the trial, for example randomized or quasi-randomized.
- Country and setting
- Method by which participants were selected
- The definition of a smoker
- Duration of the study
- Time to follow up(s)

Participants:

- The number of participants randomized to each intervention group
- Demographics of participants (age, gender, ethnicity)
- The average number of cigarettes per day, and number of past quit attempts
- Average Fagerstrom Test of Nicotine Dependence (FTND) or equivalent score
- Particular preference for abrupt or gradual cessation

Interventions:

- The method of rapid reduction intervention used
- The method of abrupt quitting intervention used
- Whether pharmacotherapy was used as part of the intervention, and if so details of use
- Details of any behavioural support provided
- Duration of reduction period
- Who delivered the intervention?

Outcomes:

- Did the trial examine whether the reduction arm reduced as instructed, and that the abrupt arm did not reduce?
- Outcomes measured
- The strictest definition of abstinence used
- Whether abstinence was biochemically verified, and if so, how
- whether enough data are available for an intention-to-treat analysis
- the proportion of quitters in each intervention arm
- the number of adverse events in each arm
- Amount of reduction in cigarettes per day in each arm (self report and/or chemical biomarkers)
- Additional outcome results
- Drop-out rates
- Information about withdrawals
- Further information about adverse events
- Missing data in both arms.

Assessment of risk of bias in included studies

Risk of bias for each trial was assessed within the domains of sequence generation, allocation concealment and incomplete outcome data, using the risk of bias table, as outlined in the Cochrane Collaboration Handbook (Handbook 2008).

Measures of treatment effect

We compared quit rates between the abrupt cessation and reduction groups, calculated on an intention-to-treat (ITT) basis, including all participants originally randomized to a trial arm. Any participants lost to follow up were treated as relapsed, excluding any deaths. We used relative risk as the summary statistic in any meta-analyses, using the Mantel-Haenszel fixed-effect model for pooling results, checking for no significant heterogeneity. We also compared the number of adverse events between arms, however no meta-analysis was carried out for this outcome as data was sparse and not consistently measured across studies.

Assessment of heterogeneity

Any inconsistency across study results was identified and assessed by examining forest plots for poor overlap of confidence intervals, and by examining the I-squared statistic.

Subgroup analysis and investigation of heterogeneity

We conducted sub-group analyses comparing trials which used pharmacotherapy as part of the interventions with those that did not. We also grouped interventions by whether or not the instruction on how to quit smoking was given alongside behavioural support or by self-help methods.

Sensitivity analysis

We tested study design by investigating the sensitivity of the main effect, when adjusting for the only cluster randomized trial eligible for inclusion in the meta-analysis and when excluding the studies where non-validated self-report data was used for the meta-analysis,

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.
See Characteristics of included studies, Characteristics of excluded studies, Characteristics of ongoing studies.

Results of the search

The searches of the Cochrane Specialised Register, MEDLINE, EMBASE and PsycINFO resulted in 543 unduplicated references. Additionally one of the authors of this review has just completed a study comparing reduction to abrupt quitting and has written a study report (Hughes 2009), which cited two further studies possibly relevant for inclusion. These 543 references were screened for eligibility based on their titles and abstracts, resulting in a reduced total of 30 studies. These studies were then independently assessed by two authors for eligibility, based on the questions specified above. We found 10 studies which were relevant for inclusion in the review based on these criteria; seven of these took place within the United States of America (Flaxman 1978; Cummings 1988; Curry 1988; Cinciripini 1995; Jerome 1999; Riley 2005; Hughes 2009), the remaining three were situated in Austria (Gunther 1992), Switzerland (Etter 2009) and Spain (Roales-Nieto 1992). We also discovered three ongoing studies (Riley 2001; Cinciripini 2006; Lindson 2009) which, when completed, may also be relevant for inclusion. The authors of eight studies (Cummings 1988; Curry 1988; Jerome 1999; Riley 2001; Riley 2005; Roales-Nieto 1992; Cinciripini 2006; Etter 2009) provided additional information when contacted.

Included studies

Characteristics of participants

The 10 included studies all recruited adult cigarette smokers with an aim to quit. Seven studies recruited participants from the community using advertisements (Flaxman 1978; Cummings 1988; Curry 1988; Cinciripini 1995; Riley 2005; Etter 2009; Hughes

2009). One study recruited work-sites to take part and then recruited their employees by posting advertisements and internal memos (Jerome 1999). Another recruited students using advertisements at a university (Roales-Nieto 1992), and another recruited patients consulting a hospital based smoking counselling service (Gunther 1992).

In one study these participants were then randomized in clusters (work-sites) to study arm (Jerome 1999), however for all other included studies participants were individually randomized. In the eight studies where participant gender was reported participants were on average evenly split between males and females, and the average reported age of participants (averaged across seven studies) was 42.8 years. Eight studies reported average baseline cigarettes per day in all participants, and this ranged from 23 to 28 cigarettes per day, with an average of 25.4.

Sample sizes

The total sample size across the 10 included studies ranged from 23 to 1895, with a mean sample size of 487. However not all conditions in all of the studies were used in the meta-analysis. When only the conditions relevant to this review were taken into account, sample sizes ranged from 14 to 1277, with a mean of 376. In five of the included studies all conditions randomized were relevant to the current review and were therefore included in the meta-analysis, however five of the studies randomized participants to interventions which were not relevant. Cummings 1988, Jerome 1999 and Hughes 2009 all included a control condition, which did not provide specific advice on how to quit, but provided information about the health implications of smoking, praise for quitting, and material emphasizing the importance of a general program of physical health (including quitting smoking) respectively. Flaxman 1978 included an immediate quit condition where participants were asked to quit the day after enrolling in the study and received substantially less behavioural support then the other conditions. Roales-Nieto 1992 included two conditions where the participants' goal was to reduce their smoking and control it rather than to reduce and quit completely. All of these conditions were deemed not relevant to this review and were excluded from any meta-analyses.

Interventions

All of the included studies had at least one group of participants who were instructed to reduce the amount they smoked before they quit, and at least one group instructed to quit smoking abruptly. In four of the studies, participants were advised on either abrupt or gradual cessation by self-help manuals or a handheld computer programme (Cummings 1988, Jerome 1999, Riley 2005, Etter 2009). Participants in another five studies were given face-to-face (Flaxman 1978, Gunther 1992, Roales-Nieto 1992; Cinciripini 1995) or telephone based (Hughes 2009) behavioural support as a means to assist either reduction or abrupt cessation. In the remaining study one reduction arm and one abrupt arm consisted of self-help therapy, and participants in the other reduction and abrupt arms were provided with behavioural support (Curry 1988). The behavioural support varied in terms of the overall length of time for which support was provided, the length of support sessions, number of support sessions, whether these were provided to individuals or groups, and who provided the support, however they all included pre-quit sessions where participants were taught strategies to help them avoid smoking when tempted, such as strategies to maximise self-control, and post-quit sessions focusing on relapse prevention. Most of the self-help interventions consisted of information booklets, some of which provided the participants with written activities. However the reduction interventions in Jerome 1999 and Riley 2005 gave participants the LifeSign handheld computer (PICS Inc); LifeSign structures a gradual reduction schedule, prompts users to smoke and allows them to record each cigarette they smoke. In the Jerome 1999 study this computer was provided, with a 48 page manual, which consisted of instructions on how to use the computer and information about behaviour modification strategies and relapse prevention. In the Riley 2005 study participants only received brief instructions on how to use the device and no further information. This was designed as a minimal contact intervention, which matched the minimal instructions provided to the abrupt quitting intervention group members, who received a calender log to record their smoking.

The abrupt quitting method advised for participants did not vary much across the ten studies. Participants were either given a quit date or asked to choose one themselves, and then asked to smoke as normal and quit abruptly on this date, with no prior cutting down. Quit dates ranged from zero to five weeks following baseline assessment. The smoking reduction interventions were more varied across studies as follows, however all reduction methods culminated in a quit day:

- Cummings 1988 gave participants unspecific advice on how to quit; they were simply advised to reduce the amount smoked over two weeks before quitting. Suggestions were provided on how they could reduce, such as setting daily goals, switching brands, changing habits and delaying the first cigarette; but ultimately it was left to participants to choose by how much to reduce and which, if any, strategies to use to achieve this.
- Three studies asked participants to reduce cigarettes per day by a certain quota over a set time interval without providing participants with any particular strategy to do so. Etter 2009 asked participants to reduce their smoking to 50% of baseline over four weeks and then quit completely. Gunther 1992 asked participants to reduce their smoking by five to ten cigarettes per week, depending on how much they were smoking at baseline, over five weeks until they were not smoking at all. Roales-Nieto 1992 instructed participants to reduce by 25% of baseline in week one, 50% in week two, 75% in week three and to quit completely in week four.

- In the Cinciripini 1995 study two groups of participants were asked to reduce their smoking; one of the groups reduced smoking by a set quota but did not use a specific technique to achieve this, as in the three studies above. Participants cut down to 66% of their baseline smoking rate in the first week of reduction, to 33% of baseline in the second week, and to 22% of baseline in the third week, until they reached two to four cigarettes per day. The second reduction group reduced by the same quota of cigarettes, but this was structured. Each week the advised smoking rate was divided by the number of hours in the participants' waking day to calculate an inter-cigarette interval. Participants were then able to smoke only in the first five minutes of each interval, and any missed cigarettes could not be accumulated for later use. Both groups quit in the week following the third week of reduction, and were combined for the purposes of our meta-analysis.
- Jerome 1999 and Riley 2005 also used inter-cigarette intervals to reduce smoking to nil. They implemented this using a handheld computer called LifeSign, which developed a smoking reduction schedule, lasting between 10 to 28 days, depending on each individual's baseline smoking rate and progress through the programme. The machine beeped and put a reminder on its screen to prompt participants to smoke.
- Hughes 2009 advised participants to reduce their smoking by 25% of baseline in week one, 50% in week two and 75% in week three, before quitting completely. They were also provided with four structured ways to do this, which they could choose between. The first was scheduled reduction where participants were advised to gradually increase the time between cigarettes (the inter-cigarette interval). The second asked participants to rate each cigarette of the day in terms of how difficult it would be to give up and then eliminate each in turn starting with the most difficult first. The third was the same as the second but participants started with the easiest first. The fourth involved the participant increasingly delaying the time from waking to the first cigarette of the day. Abstinence results did not appear to differ across the methods and so the data was pooled.
- Flaxman 1978 differed from the previous approaches as participants were not asked to reduce by a certain quota of cigarettes, but to identify situations that caused them to smoke. They were then asked to rate these situations in terms of how difficult it would be to abstain from smoking and then to eliminate smoking in one situation every three days, starting with the easiest situation and proceeding to the most difficult. In one reduction group participants continued this until they were not smoking at all and in the other they reduced until they were smoking in 50% of their baseline smoking situations and then quit abruptly. These two reduction groups were combined into an overall reduction group in our meta-analysis.
- One study gave very limited information as to how reduction took place (Curry 1988); the method was described as cigarette tapering and a gradual acquisition of coping skills. The author confirmed that this was a reduction method relevant for inclusion in this review, however no further detail could be provided.

Pharmacotherapy

Three of the studies included in this review gave participants pharmacotherapy as a part of their interventions. In all cases this was in the form of nicotine replacement therapy (NRT); one study used gum (Etter 2009), another lozenges (Hughes 2009) and the third nasal spray (Riley 2005). In the reduction arm of each study participants used the NRT both pre- and post- quit, and in the abrupt quitting arm post-quit only. In the pre-quit period Etter 2009 advised participants to use at least 10 pieces of 4mg nicotine gum per day, Hughes 2009 requested that participants replace each cigarette missed with a 2mg or 4 mg lozenge (4mg for those who smoked within 30 minutes of waking and 2mg for others). Riley 2005 signalled when participants should use the nasal spray using the same LifeSign handheld computer as was used to signal smoking. The appropriate nasal spray dosage was determined for each individual user depending on their recorded baseline smoking rate.

Outcomes

Nine of the 10 studies reported smoking abstinence as an outcome at either six month follow-up (Flaxman 1978; Cummings 1988; Hughes 2009), 12 month follow-up (Gunther 1992; Curry 1988; Etter 2009) or both (Cinciripini 1995; Jerome 1999; Riley 2005). The remaining study (Roales-Nieto 1992) reported cigarettes per day over seven days at six month, nine month and 12 month follow-ups for individual participants; it was possible to calculate abstinence rates from this information. Where abstinence was measured at six and 12 month follow-ups the 12 month rates were used in the meta-analysis. In three studies smoking abstinence was reported as point prevalence (Roales-Nieto 1992; Jerome 1999; Riley 2005), and in six studies as prolonged/continuous (Cummings 1988; Curry 1988; Gunther 1992; Cinciripini 1995; Etter 2009; Hughes 2009). Flaxman 1978 did not report how abstinence was defined. Abstinence was verified in eight of the included studies, by either expired carbon monoxide (Jerome 1999; Riley 2005; Etter 2009; Hughes 2009), saliva cotinine (Cinciripini 1995; Etter 2009), saliva thiocyanate (Curry 1988), or asking a relative or friend to confirm the participant had stopped smoking (Cummings 1988; Roales-Nieto 1992). However verified data were not used for one of the studies (Cummings 1988), as there were problems with the naming of a friend or relative to verify participants' self report. If participants did not name a person to verify their self-report, or if their self-report contradicted with their friend/relative's then they were classed as smoking, however 20% of those claiming abstinence did not provide a friend/relative. Participants who lived alone were four times more likely not to name a

person for verification than those who lived with others. All of the study reports either reported ITT analysis or provided sufficient information to allow us to calculate this, apart from Cummings 1988 where the author provided this information when contacted. Only two studies (Etter 2009, Hughes 2009) reported information about adverse events. Further information was obtained from these authors and some limited information was also obtained from the authors of Riley 2005. Reporting was not consistent across studies and so it was not possible to carry out a meta-analysis, therefore these data are synthesised qualitatively.

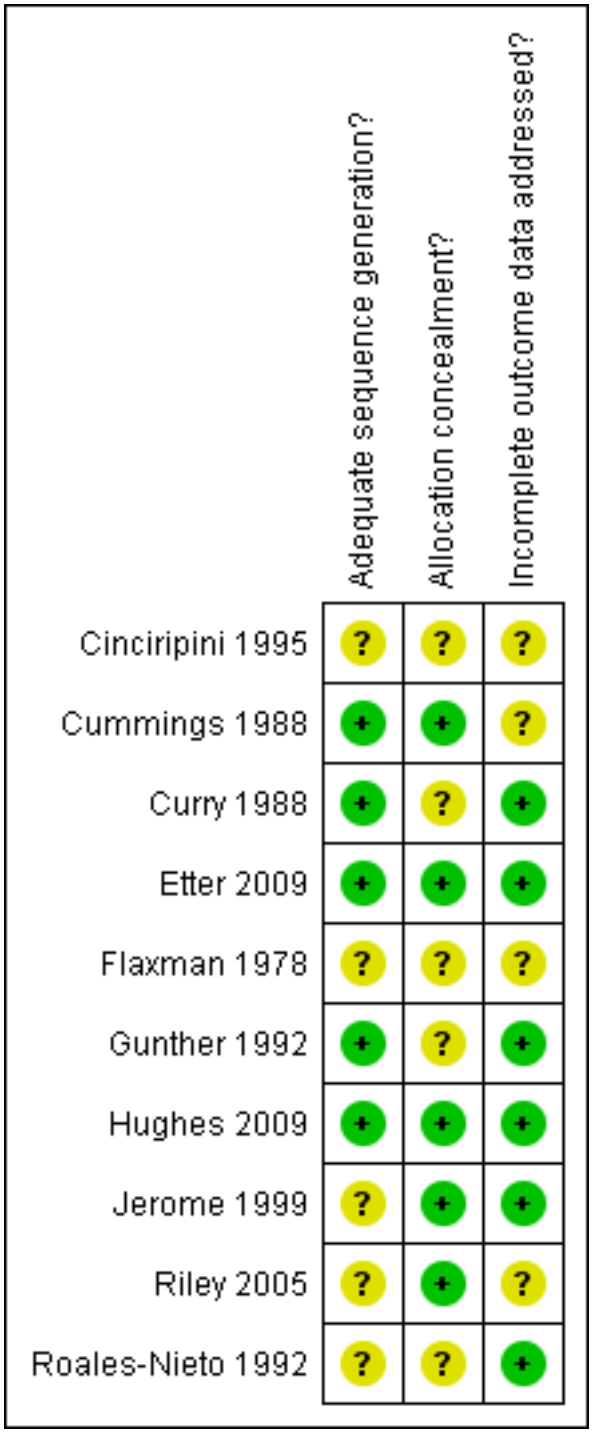
Excluded studies

Studies which were identified as potentially relevant but later excluded are listed, with reasons for exclusion, in the Characteristics of excluded studies table. The primary reasons for exclusion fell into one of three categories: 1) The goal of the intervention was to reduce smoking and control it, rather than quit (Hatsukami 1988; Bolliger 2000b), 2) the main outcome was smoking rates, and it was not possible to calculate abstinence rates from the data presented or to get these from the authors (Marston 1971), 3) both of the trial arms quit in the same way (Bernard 1972; Glasgow 1989; Cinciripini 1994; Herrara 1995; Daughton 1998; Jerome & Fiero 1999; Rose 1998; Bolliger 2000a; Schuurmans 2004; Rose 2006; Rezaishiraz 2007; Bullen 2008; Rose 2009; Shiffman 2009). Five of the excluded studies examined pre-treatment with NRT vs placebo prior to the quit date, and did not instruct smokers to reduce pre-quit. Three of these reported that participants spontaneously reduced whilst using the NRT (Rose 1998; Rose 2006; Rose 2009), two of which found that participants who reduced their smoking the most were more likely to achieve abstinence (Rose 2006; Rose 2009). However, as none of the studies instructed subjects to reduce their smoking during the pre-cessation phase of the treatment, this success cannot be attributed to an instruction to reduce and so the studies were excluded.

Risk of bias in included studies

We extracted information from each study to assess the risk of biased randomization, whether allocation concealment took place, and whether incomplete outcome data was addressed. This was assessed as either likely to cause bias (No), unlikely to cause bias (Yes) or unclear, if insufficient information was present to make a judgment (Figure 1).

Figure 1. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.



- Randomization sequence generation. Five studies reported adequate information on sequence generation to be classified as having minimal chance of bias in this regard. Five of the studies (Flaxman 1978; Roales-Nieto 1992; Cinciripini 1995; Jerome 1999; Riley 2005) did not describe the method of randomization used, and so were classified as unclear in this category. All of the studies randomized individual participants, apart from Jerome 1999 who randomized work-sites to trial arms. Trials that randomize clusters to treatment arms can be given a higher weighting than they should if data on individuals are entered in the meta-analysis. This is because the analysis assumes there is no connection between individuals in the same group in the likelihood of them stopping smoking successfully. However when we carried out an analysis adjusting for the clustering in Jerome 1999, although the study weighting decreased from 22% to 17% the main result was not sensitive to the adjustment (Risk ratio (RR)= 0.93, 95% CI= 0.78 to 1.12). This adjustment used an intra-class correlation of 0.0105 (as recommended by Martinson 1999 for an outcome of percentage quit in the work place) and an average number of people per group of 18.3 (design effect = 1.18).
- Allocation concealment. When rated in terms of allocation concealment from clinicians enrolling participants into studies, four studies (Cummings 1988; Jerome 1999; Riley 2005; Etter 2009) were rated as unlikely to cause bias, as all interventions consisted of self-help therapy and there was either no or minimal contact with investigators/enrolling clinicians. Consequently, participants enrolment in the studies could not depend on knowledge of the allocation sequence as there was no clinician deciding on whether to enrol or which treatment to give. Hughes 2009 was also rated as unlikely to cause bias in this category as a statistician generated a concealed allocation sequence. The five remaining studies did not report on allocation concealment and were therefore classed as unclear.
- Incomplete outcome data. In the category of incomplete outcome data six studies were classed as unlikely to cause bias, as participant attrition was reported as similar in all trial arms. The four remaining studies were classed as unclear; three of the studies (Flaxman 1978; Cinciripini 1995; Riley 2005) did not provide any information about participant attrition or missing data, and the abstinence rates table in the Cummings 1988 report appeared to leave 18 participants unaccounted for. Due to the length of time since the study had been completed the author could not confirm why this was the case, but did provide further information so that an intention-to-treat analysis could be carried out, in which the missing participants were classified as not abstinent. Participants attrition in general was similar across arms, however the study was classified as unclear as we didn't know the allocation of the missing participants and whether this was similar across arms.

Two of the included studies (Flaxman 1978; Cinciripini 1995) were rated as unclear for all three of the above bias categories and another two were rated as unclear for two (Roales-Nieto 1992; Riley 2005). We carried out a sensitivity analysis to establish whether the main result was sensitive to the exclusion of these four studies and found that it was not (RR= 0.94, 95% CI= 0.76 to 1.16).

Other potential sources of bias were failure to verify smoking abstinence by biochemical means and whether participants conformed to their allocated intervention.

- Biochemical verification. Studies that did not validate self-reports of abstinence (Flaxman 1978; Gunther 1992), or where validation was potentially flawed, and therefore not used in this review (Cummings 1988) could potentially over-estimate abstinence. However we would not expect this to differ between arms, and a sensitivity analysis confirmed that the main findings were not sensitive to the exclusion of studies where abstinence was not validated (RR= 0.91, 95% CI= 0.74 to 1.12). SRNT 2002 concludes that population based studies with limited face-to face contact, and where data collection is optimally by mail, telephone, or on the Internet are unlikely to benefit from biochemical verification. Population studies have much higher biochemical verification refusal rates than clinic based studies, if all participants who refused were classed as smoking then this would be likely to overestimate smoking rates. In reality the extent that self-reports inflate abstinence rates is small and rarely differs across conditions. Also, in studies where there is very little contact with an investigator or therapist this reduces demand characteristics, meaning there is little incentive to lie.
- Adherence to method of quitting allocated. Six of the 10 studies assessed whether participants followed the instructions they had been given on how to quit i.e. to reduce or quit abruptly without prior reduction. Three of these studies (Roales-Nieto 1992; Etter 2009; Hughes 2009) found that participants followed instructions; the participants in the reduction group reduced before quitting and the participants in the abrupt group quit abruptly with no prior reduction. Cinciripini 1995 found that the reduction group complied well with their instructions but the abrupt group also reduced by seven to eight cigarettes per day less than baseline before quitting. However the reduction group smoked significantly fewer cigarettes than the abrupt group before quit day. The two remaining studies to report on adherence to the intervention allocation found that participants did not abide by intervention instructions. In Flaxman 1978 the group which reduced until they were not smoking at all reduced by a mean of 6 cigarettes per day, and the group who reduced to 50% of baseline then quit reduced by a mean of 3.5 cigarettes per day. However the abrupt quit group also reduced by an average of 3.4 cigarettes per day before they quit, meaning there

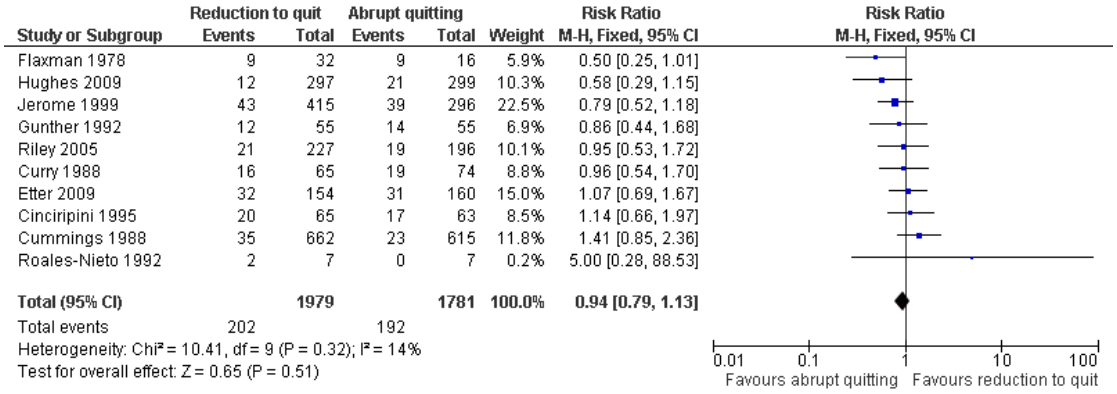
was little difference between reduction in the partial reduction group and the abrupt quit group. Cummings 1988 asked participants after quit day whether they had quit abruptly. 39% of participants in the abrupt group quit abruptly and 40% of the reduction group also quit abruptly, therefore there appeared to be little difference between the arms in the methods of quitting that were actually used. As is the case with all ITT analyses, it is only ever possible to examine the effect of allocation to a quitting method, not the effectiveness of actually following it.

Effects of interventions

Abstinence Outcome

The meta-analysis included 10 trials with a total of 3760 participants. There was evidence that reduction produced similar quit rates to abrupt cessation and that any difference in effectiveness was small. The overall rate ratio for abstinence for reduction versus abrupt cessation was 0.94, 95% CI= 0.79 to 1.13 (Figure 2). There was low heterogeneity (I^2 = 14%), suggesting that the effect of reduction relative to abrupt cessation did not differ across trials. For all studies confidence intervals spanned one, indicating no study achieved statistically significant superiority of either gradual or abrupt cessation. We have not reported pooled quit rates because studies varied on a number of factors, such as definition of abstinence (point prevalence or prolonged), length of abstinence (6 months or 12 months), whether or not behavioural support was provided , and whether pharmacotherapy was provided, meaning that average rates would not be useful.

Figure 2. Reduction to quit versus abrupt quitting. Outcome: abstinence



The effect of gradual versus abrupt cessation in participants using pharmacotherapy

The studies were split into two sub-groups to assess whether the effect of gradual cessation depended on whether people used smoking cessation pharmacotherapy or not. One sub-group included studies that didn't use any pharmacotherapy as part of the interventions (Flaxman 1978; Cummings 1988; Curry 1988; Gunther 1992; Roales-Nieto 1992; Cinciripini 1995; Jerome 1999). The other sub-group included the remaining studies (Riley 2005; Etter 2009; Hughes 2009), which utilised nicotine replacement therapy pre- and post-quit in the reduction interventions and post-quit in the abrupt interventions. There was no evidence of the superiority of either gradual or abrupt cessation whether pharmacotherapy (NRT) was used (RR= 0.89, 95% CI= 0.65 to 1.22), or not (RR= 0.97, 95% CI= 0.78 to 1.21), and neither was there evidence that pharmacotherapy modified the effect of reduction versus abrupt cessation (Analysis 1.2).

The effect of the type of behavioural support utilized

We also conducted a sub-group analysis by the type of therapy provided. Some of the included studies used self-help therapy (Cummings 1988; Jerome 1999; Riley 2005; Etter 2009), and some behavioural support (Flaxman 1978; Gunther 1992; Roales-Nieto 1992; Cinciripini 1995; Hughes 2009). Curry 1988 included study arms that were self-help and others that were behavioural, so these were split accordingly for the sake of this analysis. Again the risk estimates were similar whether the instruction in how to quit and support for achieving this was given by self-help (RR= 0.98 95% CI= 0.78 to 1.23) or by behavioral support (RR=

0.87 95% CI= 0.64 to 1.17), and neither reduction nor abrupt quitting resulted in superior quit rates in either case (Analysis 1.3).

Adverse Events Outcomes

The secondary objective of this review was to compare adverse events between arms, however no attempt has been made to do this quantitatively as there was a a lot of variation in nature and depth of reporting. The seven studies that did not utilise pharmacotherapy did not report information about adverse events. Of the three studies using pharmacotherapy, Riley 2005 reported no information on adverse events in the study report, but the author kindly supplied further information for this review. Etter 2009 and Hughes 2009 also provided additional information as well as data reported in the publications. Etter 2009 and Riley 2005 reported that no participants in these studies experienced serious adverse events. Etter 2009 also provided data obtained in response to the question: "If you experienced undesirable effects due to the nicotine gum, please describe them" (open ended question), asked two months after target quit day. Overall the most commonly reported symptoms were mouth pain/dry mouth/throat burns, hiccups, stomach pain/heartburn- the most common side-effects from oral NRT. Nine of the total symptoms reported occurred more frequently in the reduction groups (mouth pain/dry mouth/throat burns, hiccups, stomach pain/heartburn, pain/cramp in jaws, mouth ulcers, headache, eructation, heart palpitations, cough) four in the abrupt groups (nausea, bad taste, insomnia, vomiting) and three were reported as frequently in both groups (malaise, constipation, diarrhoea). Hughes 2009 reported that the incidence of adverse events rated severe was small and similar across conditions. 3% of participants randomized to the reduction to quit group reported severe adverse events and 5% of the abrupt quit group; the incidence of discontinuation was 1% for both groups.

DISCUSSION

The 10 studies included in this review compared interventions that instructed participants to quit smoking gradually by reducing the amount they smoke with interventions that instructed participants to quit smoking abruptly without prior reduction. The results provide evidence that reduction to quit provides similar quit rates to abrupt quitting with no evidence that one method is significantly superior to the other in adults trying to quit smoking. This applies whether therapy is self-help or includes behavioural support and whether the quit attempt uses NRT or not. The similarity of the result in the NRT sub-group and the non NRT sub-group suggests that the success of the reduction interventions relative to the abrupt quit interventions is not due to the use of pre-quit NRT. We were unable to combine data on absolute quit rates as studies varied on a number of factors expected to influence quit rates, for example length of follow-up, and so can not provide meaningful estimates of average quit rates as a result of reduction to quit and abrupt quit interventions.

We were unable to combine statistically the adverse events data, and therefore could not determine whether adverse events differed significantly between the intervention groups that reduced and used NRT pre- and post-quit, and the intervention groups where participants quit abruptly and used NRT post-quit. However a recent review conducted a meta-analysis (Moore 2009) of seven placebo controlled RCTs, which used NRT to assist reduction to stop smoking and found that there were no significant differences in deaths (odds ratio (OR)= 1.00, 95% CI= 0.25 to 4.02), serious adverse events (OR= 1.16, 95% CI= 0.79 to 1.50), and discontinuation due to adverse events (OR= 1.25, 95% CI= 0.64 to 2.51), between the placebo and NRT interventions. The only adverse event that was more common in the NRT interventions was nausea (OR= 1.69, 95% CI= 1.21 to 2.36), which is a common side effect of nicotine replacement therapy. Taken with other safety data on concurrent smoking and use of NRT (Fagerstrom 2002), there appears to be no reason to recommend against the practice of gradual reduction assisted by NRT. At least one trial shows that among smokers trying to quit smoking by gradual reduction, using NRT is more effective than use of placebo in supporting abstinence (Shiffman 2008), and a Cochrane Review of smoking harm reduction (Stead 2007) found that people who did not originally want to quit smoking were more likely to be abstinent from cigarettes at long-term follow-up when NRT was used as an aid to reduction than when a placebo was used (OR= 1.90, 95% CI= 1.46 to 2.47). On this basis, if reduction is to be used as a means of quitting, use of NRT or other pharmacotherapy appears desirable. NRT is licensed for use in this way in the UK and Australia, however the US Medicines Regulator, along with other pharmaceutical regulators have not yet licensed NRT for this purpose.

An important limitation of any meta-analysis is that methods vary across studies and the underlying assumption that the meta-analysis is trying to estimate a single true rate ratio might not hold. In this instance patient populations, outcome definitions, provision of pharmacotherapy and the behavioural support provided varied across the included trials. Despite this, the measure of heterogeneity was low suggesting that heterogeneity of these elements did not translate into heterogeneity of effectiveness of reduction. One of the studies also varied because it used cluster randomization, but sensitivity analysis suggested that allowing for this or not had little influence on the result of the meta-analysis. Four of the studies included in the meta-analysis (Flaxman 1978; Cummings 1988; Curry 1988; Cinciripini 1995) had more than one intervention that qualified as reduction and/or abrupt quitting, and we combined these to create one reduction arm and one abrupt quit arm per study. We considered entering the data for each trial arm separately to see if this would give us any more detailed information about the relative success of different reduction meth-

ods, however the methods used differed in each study (scheduled, non scheduled, group behavioural support, individual behavioural support, reduction to zero cigarettes before quit, reduction to 50% of baseline before quit etc), so they could not be pooled for a subgroup analysis, and therefore would be no more informative than the original studies.There is however some evidence that structured methods of reduction are more effective than simple advice to cut down without following specific methods (Levinson 1971; Cinciripini 1995).

Two of the 10 included studies (Etter 2009; Hughes 2009) were assessed as unlikely to cause bias for all three categories assessed. These studies were the most recent of the 10 studies, which may suggest that their increased reporting, relative to the other eight studies, is due to awareness of the revised CONSORT reporting guidelines (Moher 2001), which were published in 2001, and advise reporting methods of sequence generation and allocation concealment, and a flow diagram illustrating the flow of participants through the study. Seven of the studies rated in at least one bias category as 'No' or 'Unclear' were published before 2001 and the remaining study was not written up for publication. Therefore lack of reporting may be for these reasons rather than because bias is present. This may also explain why the reporting of adverse events was only present in the most recent studies. The main results of the two most recent studies do not differ much from the main results of the eight older studies, therefore there is no evidence that studies reporting better randomization procedures produced different results. Many of the older studies did not propose a hypothesis that favoured either a reduction or an abrupt quitting intervention (Flaxman 1978; Curry 1988; Gunther 1992; Roales-Nieto 1992; Cinciripini 1995) so in the cases where allocation concealment was not reported, and so may not have occurred, there is no reason why allocation would have been carried out to favour any particular arm.

Whilst assessing studies for eligibility there were two studies (Curry 1988; Jerome 1999) where uncertainty arose about whether the intervention methods were abrupt or reduction to quit. Curry 1988 reported that one method of quitting used in the study was "cold turkey" and that the other was "tapering and nicotine fading". There is no further detail given on these methods so we contacted the authors who confirmed that one of these methods was an abrupt quit method and the other was a reduction to quit method, which met our inclusion criteria. Jerome 1999 consisted of a study arm where participants reduced and then quit using a handheld computer, and an arm where participants were provided with an American Lung Association self-help booklet called "Freedom From Smoking For You and Your Family". The study report did not specify whether this booklet advised an abrupt quitting method or a reduction to quit method and the authors and the American Lung Association were unable to provide additional information. However Davis 1992 includes a table comparing the content of three self-help guides including this one, which reported that the topic of cutting down smoking is not covered. We therefore believe that including these studies in the review is appropriate. The failure of studies to clarify methods used to achieve abstinence does raise the possibility that studies could have been missed because authors described them in terms we did not expect. We followed up included studies reference lists to check for other studies that came up in our search and we found no other studies. Nevertheless, we could have failed to include all extant studies but there is no reason why publication bias or failure to find less clearly described or less prominent studies would be expected to bias the results towards reduction or abrupt cessation methods.

Surveys carried out in the general population (West 2001; Cheong 2007) have found that gradual quitting isn't as effective as abrupt quitting, however these differ from the RCTs included in this meta-analysis in ways that may explain the difference in outcomes. The participants quitting gradually in the RCTs (whether support was behavioural or self-help) were all provided with some instructions as to how to quit, which included setting quotas of cigarettes to reduce by, and setting time intervals at which participants could smoke. All of the included studies also appeared to require participants to set a target quit day providing them with a goal to work toward. However the participants included in the observational studies will have quit using a number of methods of gradual reduction, and it is likely that these will vary in their levels of success. The UK and US national guidelines do not recommend cutting-down before quitting and therefore services such as the UK NHS Stop Smoking Services (NHS SSS) only offer abrupt quitting as a cessation method. This means that those participants who chose gradual cessation were less likely to have benefited from any kind of support whilst quitting (behavioural or self-help materials), which in the case of the NHS SSS has been found to increase quit rates by up to four times. Therefore quitters choosing gradual reduction are automatically put at a disadvantage. A person who quits without support is also more likely to use an unstructured method, with no reduction goals, no particular method of reducing, and no target quit day. Cinciripini 1995 found that those participants that quit using unstructured reduction were less successful than those who used a more structured method. Two previous meta-analyses (Law 1995; USPHS 2008) have looked at nicotine fading as a smoking cessation intervention. These, however, differ from the current analysis, because as well as including studies where participants were asked to reduce nicotine intake by reducing the number of cigarettes they smoked, they also included studies where participants were asked to use graduated filters to remove progressively more nicotine from inhaled smoke, and studies where participants changed brands to cigarettes of successively lower nicotine yield. We chose not to combine all of these approaches in the current analysis as there is reason to believe that these methods do not all work by the same mechanisms. For example, one of the ways reducing cigarettes smoked may work is by weakening links between environmental cues (e.g. socialising) and smoking a cigarette. This wouldn't be applicable to using nicotine filters as

the person is still smoking in all the same situations and therefore still associates smoking with the same environmental cues. One of the reviews (Law 1995) compared the gradual quitting interventions with sudden or abrupt cessation as we have done in this case, however the second (USPHS 2008) compared nicotine fading with untreated control conditions and therefore the relative effectiveness of reducing nicotine intake and abrupt quitting was not reported. USPHS 2008 found that there was no effect of using nicotine fading techniques when compared to no treatment, however Law 1995 found that gradual cessation was 5% (95% CI= -2% to 11%) more effective than abrupt quitting, although this difference was not significant (p>0.10). Therefore as in this analysis neither abrupt quitting or reducing to quit provided superior quit rates.

The result of this analysis suggests that public health messages on cessation and cessation services supporting individuals who smoke could advocate or offer reduction as a way to quit for people who intend to quit soon. They can be confident that if people choose to quit by reducing before stopping entirely, this would not put them at a disadvantage compared with those who choose to smoke as normal and then quit abruptly. Reduction to quit might help those who have tried to quit a number of times without success and are disillusioned with the abrupt quit method. Having a new way to quit could give renewed hope, especially as many smokers see reduction as an intuitive first step toward stopping smoking completely. Offering reduction to quit may also appeal to those who would otherwise not have sought behavioural support and pharmacotherapy because they want to pursue gradual cessation and this is not currently supported. This would then enhance the proportion of the population that make assisted quit attempts and boost population cessation rates . Without help, around 4% of people who try to stop smoking sustain abstinence for one year (Hughes 2004), but with the aid of cessation treatment in the UK, around 15% of quitters abstain for a year (Ferguson 2005). This increase in success when behavioural support is provided suggests that we should be trying to encourage as many people as possible into cessation services. Our sub-group analysis, however, suggests that reduction is as successful as abrupt quitting whether the intervention consists of behavioural support or is self-help. Therefore this result could also benefit people who want to quit smoking on their own without behavioural support. If people who smoke are aware of an additional effective quitting method then this could also encourage more of them to quit who want to do so independently.

Reduction versus abrupt quitting risk ratios vary across the studies included in this meta-analysis (from Flaxman 1978: RR= 0.50, 95% CI= 0.25 to 1.01 to Roales-Nieto 1992: RR= 5.00, 95% CI= 0.28 to 88.53). We would expect the effect of the abrupt interventions to be constant across studies as abrupt quit instructions did not vary, therefore there may be a difference in the success rates of different reduction methods. This is supported by the fact that gradual reduction has been found to be less successful than abrupt quitting in observational studies, but as successful in RCTs. The studies included in this review used a number of different methods, including scheduled reduction, non-scheduled reduction, reducing to zero cigarettes before quitting, reducing to 50% of baseline before quitting. There are conceivably many more ways that people could reduce before going on to quit completely. Trials that have been carried out so far to compare different reduction methods are small and often participants aim to reduce rather than to quit completely. There has been no attempt to combine all of these studies into a review so that conclusions can be drawn and applied to policy development. Therefore further research needs to be carried out to investigate the methods of gradual reduction that smokers in the general population are using, and whether they are using any type of support alongside, to see whether this accounts for the difference in results between observational studies and RCTs. Further work is needed to identify the most effective reduction methods in those wanting to quit. Ideally this would be a review which amalgamates existing evidence and identifies literature gaps, leading to large-scale RCTs that directly compare different methods. In turn, this could inform policy and service development as to the most successful reduction to quit method(s). If there are marginal differences in the effects of different reduction methods then quitters could choose from a number of options. However, if there are methods shown to be significantly less effective, quitters should not be advised to use them as this might disadvantage them. It may prove useful to establish whether different quitting methods benefit different groups of smokers, e.g. a particular method may benefit a highly addicted smoker more than a less addicted one. If so, then a person could use a quitting method tailored to their individual profile, to produce the optimal likelihood of abstinence.

In summary, we found no big differences in effectiveness between advising people who smoke to quit abruptly or advising them to reduce cigarette consumption prior to quit day i.e. gradual quitting. These results apply to gradual quitting methods that all employed a definite quit day and it is not clear whether telling people to cut down and quit when they are ready would achieve the same results. Given these findings, it seems reasonable to offer smokers a choice of whether to cut down in preparation for quitting or to continue to smoke as normal and quit abruptly.

AUTHORS' CONCLUSIONS

Implications for practice

- Patients can be given a choice to quit smoking either by reducing cigarettes smoked before quitting or by quitting abruptly with no prior reduction.

- Reduction to quit can be implemented via self-help therapy or with the aid of behavioural support.

- NRT can be used to aid pre-quit reduction.

Implications for research

- Further research should focus on methods of reduction that smokers in the general population use to quit and whether they utilise behavioural or self-help support alongside these.

- A review of the existing literature on methods of smoking reduction is needed, and RCTs developed to determine which methods of reduction are the most effective.

- Research is needed to try and establish people who may benefit most from the abrupt and gradual approach to quitting smoking, in order to tailor smoking cessation to individuals.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Cinciripini 1995

Methods	Country: USA Recruitment: participants recruited from the community, method not stated.
Participants	128 smokers randomized to 4 groups, with at least 3 years smoking history, consumption of 15+ cigarettes per day (CPD), no current cessation treatment, psychiatric disorder or uncontrolled systemic illness. 58% F, av. age 45, av. CPD 24, av. 4 previous quit attempts.
Interventions	1. Scheduled reduced: inter-cigarette interval progressively lengthened, until quit day at week 5. 2. Non-scheduled reduced: CPD reduced using same quota as scheduled group but participants were free to choose when they smoked their cigarettes, until quit day at week 5. 3.Scheduled non-reduced: participants instructed to smoke at regular time intervals but the time intervals were not progressively reduced to quit day at week 5. 4. Non-scheduled, non-reduced: No manipulation of inter-cigarette interval or cigarette frequency, until quit day at week 5. Pharmacotherapy: No pharmacotherapy Type of support: Two-hour weekly group meetings; cognitive behavioural intervention weeks 2-5; relapse prevention weeks 5-9.
Outcomes	Abstinence: Prolonged abstinence (defined as smoking on fewer than 5 days between assessments) at treatment end (week 9) & 1, 6 and 12 month post-treatment. (PP at quit week (week 5) also reported). Validation: CO <6ppm at quit week, cotinine <14 mg/ml at treatment end & 1,6 and 12 month follow-up Other outcomes: CPD, coping behaviour, withdrawal score, tension & fatigue mood states, urge frequency, self-efficacy.
Notes	Groups 1 and 2 combined to create reduction group and Groups 3 & 4 combined to create abrupt quitting group.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Randomized, method not stated.
Allocation concealment?	Unclear	No information given.
Incomplete outcome data addressed? All outcomes	Unclear	Information on attrition/exclusions not given. Those with missing data were counted as non-abstainers.

Cummings 1988

Methods	Country: USA Recruitment: callers responding to advertisement of stop smoking hotline, who accepted a free stop smoking booklet.
Participants	1895 randomized to 4 experimental groups and 1 control group. 18+ year old current smokers. 65% F, av. age 42, av. CPD 28, av. 3 previous quit attempts.
Interventions	1. Booklet instructing smokers to gradually reduced cigarettes smoked before quitting. Day by day structured guide. 2. Booklet instructing smokers to gradually reduced cigarettes smoked before quitting. No day by day instructions. 3. Booklet instructing smokers to quit abruptly. Day by day guide. 4. Booklet instructing smokers to quit abruptly. No day by day instructions. 5.Control: booklet providing information on the health hazards of smoking and the nature of tobacco addiction, but did not give specific advice on how to stop smoking. Pharmacotherapy: No pharmacotherapy. Type of support: Self-help booklet.
Outcomes	Abstinence: Continuous between 1 month & 6 month follow-up. (1 week PP at 1 & 6 months post-enrolment, 1 month prolonged at 6 months post-enrolment also reported) . Validation: surrogate interview conducted with family member or friend. Other outcomes: report of cessation attempt, cigarettes per day, percentage of booklet read, booklet evaluation, actions taken in preparation for quit and after quit, method of quitting.
Notes	Groups 1 and 2 combined to create reduction group and Groups 3 & 4 combined to create abrupt quitting group. Surrogate interview validation data not used as there were problems with allocation of a surrogate- 20% of the quit participants refused to provide a surrogate, and participants were less likely to give a surrogate if they lived alone.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	"randomization was done from a pre-randomized list so subjects were randomized as they called into the study and were defined as eligible" (email communication).
Allocation concealment?	Yes	Self-help intervention involving minimal contact with investigators/enrolling clinicians, risk of bias assessed as low.
Incomplete outcome data addressed? All outcomes	Unclear	19.1% of total randomized lost to follow-up, reported not to vary by arm. 18 additional participants missing from report results table, these participants are in-

Cummings 1988 (*Continued*)

		cluded in the current analyses and treated as non abstainers, however their allocation to treatment arms is unknown.

Curry 1988

Methods	Country: USA Recruitment: from the community via radio announcements and newspaper adverts offering stop smoking program.
Participants	139 cigarette smokers randomized to 4 experimental groups. 51% F, av. age 40.6, av. CPD 28, av. 3.7 previous quit attempts.
Interventions	1. Reduction (Absolute abstinence)-group based: cigarette tapering and nicotine fading before quit day in week 5. Groups met once a week for two hours, for 8 weeks. 2. Reduction (Absolute abstinence)-self-help: cigarette tapering and nicotine fading before quit day in week 5. Provided with work books with written exercises. 3. Abrupt (Relapse prevention)-group based: quit abruptly at week 3. Groups met once a week for two hours, for 8 weeks. 4. Abrupt (Relapse prevention)-self-help: quit abruptly at week 3. Provided with work books with written exercises. Pharmacotherapy: No pharmacotherapy Type of support: Self-help booklet and group behavioural support.
Outcomes	Abstinence: Prolonged abstinence from at least month 9 to month 12 at 12 month follow-up (PP at EOT and 3 months post treatment also reported) Validation: saliva thiocyanate test during final week of treatment and at 12 month follow-up. Other outcomes: time to relapse, number of quit attempts, returns to abstinence after lapse.
Notes	Groups 1 and 2 combined to create reduction group and Groups 3 & 4 combined to create abrupt quitting group for the main analysis. For sub-group analysis this study was split back into 4 groups to look at self-help and behavioural support interventions separately.

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	"Participants were stratified by availability for day or evening group meetings. Within each stratum a total of 24 participants were picked randomly and were grouped into pairs of 12. A coin toss determined assignment to the RP or AA program."
Allocation concealment?	Unclear	No information given.

Curry 1988 (*Continued*)

Incomplete outcome data addressed? All outcomes	Yes	Significantly more participants assigned to self-help treatment withdrew (64% vs 36% in group condition) before treatment began suggesting assignment to self-help was the overriding contributor to attrition. It is reported that there was no difference in participation rates between the reduction and abrupt quit groups.

Etter 2009

Methods	Country: Switzerland Recruitment: from the community through advertisements on a smoking cessation web site (http://www.stop-tabac.ch), via newspaper advertisements, and by physicians in private practice.
Participants	314 participants randomized to 2 groups, smoking at least 15+ CPD, aged 18+, with a commitment to quit smoking on a target date in the next two months, and to use 10+ pieces of nicotine gum per day. 41.3% F, av. age 43.1, av. CPD 23.7, 42.4% had made a 24hr quit attempt in the past 12 months.
Interventions	1. Pre-cessation treatment group: received recommendation to decrease cigarette consumption by half before quitting roughly 2 months after baseline, whilst using nicotine gum. 2. Usual care: received instruction to quit abruptly on a target quit date, roughly 2 months after baseline. Pharmacotherapy: Unflavoured 4 mg nicotine gum. 4 weeks pre-quit in pre-cessation arm and 8 weeks post-quit in pre-cessation and usual care arm. Type of support: Self-help- booklet in the mail and a smoking cessation web site.
Outcomes	Abstinence: 7 day, 4 week, 6 month, and 12 month prolonged abstinence at 12 months post-quit (PP at 3 days post-quit. 7 day , 4 week, 2 month prolonged abstinence at 8 weeks post-quit (EOT) also reported) Validation: CO and saliva cotinine at 12 month follow-up. Other outcomes: self-efficacy, preference for study group, method of quit, gum use, CPD in pre-quit week, cravings, dependence, attitudes toward smoking, appetite, hunger, withdrawal, anxiety and depression, weight gain.
Notes	

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Yes	"Randomization was based on a list of random numbers generated by a computer."

Etter 2009 (*Continued*)

Allocation concealment?	Yes	Self-help intervention involving minimal contact with investigators/enrolling clinicians, risk of bias assessed as low.
Incomplete outcome data addressed? All outcomes	Yes	Participation rates were similar in both arms at all time points: 11% of reduction group and 12.5% of abrupt group lost to follow-up at 12 months.

Flaxman 1978

Methods	Country: USA Recruitment: by means of public service announcements of a smoking cessation clinic on television, radio and in local newspapers
Participants	64 cigarette smokers randomized to 4 groups. 50% F, av. age not reported, av. CPD 26, 42.4% av. 3 previous quit attempts.
Interventions	1. Gradual reduction: stimulus hierarchy technique- situations leading to smoking were categorised and rank ordered according to anticipated difficulty of not smoking in each. Participants were instructed to give up in the easiest situation first, progressing to the hardest. Adding one situation every three days. 2. Partially gradual reduction: Same as gradual reduction, however participants quit abruptly when their smoking rates dropped to half of baseline. 3. Target date: a date approximately 2 weeks from the first session was selected for abrupt quitting. 4. Immediate quit: participants were scheduled to quit smoking the next day. Pharmacotherapy: No pharmacotherapy. Type of support: Behavioural. Participants met with experimenters twice a week for 0.5 hour sessions pre-quit and were presented with self-control techniques.
Outcomes	Abstinence: measured at 1 week and 6 months post-treatment. No further definition of abstinence given. Validation: No information given. Other outcomes: mean daily post-treatment smoking rates (weeks1-8 and 6 months). percentage of baseline smoked.
Notes	Groups 1 and 2 combined to create reduction group and Group 3 abrupt quitting group. Group 4 data was not used as this group received a lot less behavioural support than the other groups. Participants in each group were also split into one of two phase 2 post-quit interventions, however there was no difference between these two conditions at 6 month follow-up so this is not taken into account.

Risk of bias

Item	**Authors' judgement**	**Description**

Flaxman 1978 (*Continued*)

Adequate sequence generation?	Unclear	Randomized; "Sixty-four subjects were blocked by sex and number of cigarettes smoked per day and randomly assigned to one of the eight treatment cells and to two of the six experimenters", precise method not described.
Allocation concealment?	Unclear	No information given.
Incomplete outcome data addressed? All outcomes	Unclear	No information given.

Gunther 1992

Methods	Country: Austria Recruitment: patients consulting a hospital based smokers' counselling service between Februaury and December 1988.
Participants	110 participants randomized to 2 groups, examined by a psychiatrist to determine tobacco dependence, value of 6+ on Fagerstrom tolerance questionnaire. Av. CPD 26.4.
Interventions	1. Gradual stopping: From the second hour of counselling the number of cigarettes was reduced, depending on initial consumption the number of cigarettes was reduced by 5-10 cigarettes per week. 2. Sudden stopping: a quit date was set on which participants quit abruptly. Pharmacotherapy: No pharmacotherapy. Type of support: Behavioural - Total of 12 hours of counselling (1 hour per week).
Outcomes	Abstinence: 1 year prolonged (relapse during the 1 year follow-up period= resumption of nicotine use for more than 3 days at follow-up date). Validation: No validation at 1 year follow-up. Other outcomes: response rates, number of CPD at 1 year follow-up, relapse.
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	"computer generated randomized list".
Allocation concealment?	Unclear	No information given.
Incomplete outcome data addressed? All outcomes	Yes	Only the participants initially abstinent were followed to one year (76% sudden, 73% gradual). Of these, loss to follow-up was 36% in the sudden stopping group and 22% in the gradual stopping group (non

Gunther 1992 (*Continued*)

		statistically significant difference).

Hughes 2009

Methods	Country: USA Recruitment: respondents to local newspaper and radio advertisements.
Participants	746 daily smokers randomized to 3 groups, smoking at least 15+CPD, with no increase or decrease in CPD by 20%+ in last month. 54% F, av.age 48, av. CPD 23.
Interventions	1. Gradual: participants could choose from four reduction methods to reduce smoking by 25% week 1, 50% week 2, 75% week 3, quit week 4 2. Abrupt: participants advised not to change their CPD prior to set quit day. 3. Brief Advice: praised on decision to quit, not advised how to do so. Pharmacotherapy: NRT (lozenges) used pre-quit in gradual group, participants were advised to substitute one lozenge for each cigarette missed. All participants used lozenges post-quit contingent upon abstinence. Type of support: Behavioural - over the telephone. Both gradual and abrupt groups received 5 calls (90 minutes).
Outcomes	Abstinence: prolonged abstinence from 2 weeks-6 months follow-up (7-day PP at 6 m also reported). Validation: CO at 6 month follow-up. Other outcomes: quit attempts, self-efficacy, severity of dependence, stereotypy, craving, motivation to quit.
Notes	Only the data from the gradual and abrupt groups are of interest to this review as participants in the brief advice group were not advised to quit in any particular way.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Yes	"..our statistician generated a concealed allocation sequence and randomized the participant to the gradual, abrupt or brief advice conditions in a 2:2:1 ratio using blocked randomization (stratified by city and counsellor) based on the SAS procedure PLAN (Cary, NC: SAS Institute, Inc) "
Allocation concealment?	Yes	"..our statistician generated a concealed allocation sequence.."
Incomplete outcome data addressed? All outcomes	Yes	The incidence of adverse events was similar and small across conditions (3% gradual, 5% abrupt, 3% brief intervention), and in-

		cidence of discontinuation was lower than 1% in total. Drop out rates were also similar across groups; loss to follow-up was 20.7% in the abrupt group and 23.6% in the gradual group at 6 months.

Jerome 1999

Methods	Country: USA Recruitment: work-sites recruited smokers who wanted to quit to a free work-site self-help smoking cessation program. Recruitment was via posted advertisements and internal memos to employees.
Participants	1025 adult smokers from 61 work-sites randomized to 3 groups. 61.8% F, av. age 37.5, av. CPD 24.
Interventions	1. Computerized, scheduled, gradual reduction (with LifeSign program): Handheld computer used to increase the inter-cigarette interval until quit and record smoking. General advice on coping with urges and maintaining abstinence provided by a manual. 2. American Lung Association (ALA) quit smoking manual provided to participants: 'Freedom From Smoking For You and Your Family'. Includes standard behavioural techniques but not cutting down before quit. 3. General wellness information: printed material provided emphasizing the importance of a general program of physical health that included quitting smoking , exercise and sound nutrition. No specific quitting techniques provided. Pharmacotherapy: No pharmacotherapy. Type of support: Self-help materials.
Outcomes	Abstinence: 7-day PP at 12 month follow-up (from treatment initiation) (PP at EOT, & 6 m also reported) Validation: CO at all follow-ups. Other outcomes: program use, ease of use, effectiveness of program.
Notes	Only the data from the gradual reduction and ALA groups are of interest to this review as participants in the general wellness group were not advised to quit in any particular way.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Cluster randomized: "Work-sites were randomly assigned to one of three treatment conditions," precise method not described.
Allocation concealment?	Yes	Self-help intervention involving minimal contact with investigators/enrolling clinicians, risk of bias assessed as low.

Jerome 1999 (*Continued*)

Incomplete outcome data addressed? All outcomes	Yes	Loss to follow-up was comparable in the two arms of interest;13% gradual reduction, 17% ALA at 12 months. Analysis undertaken as intention to treat.

Riley 2005

Methods	Country: USA Recruitment: Respondents to local television spots who were then screened by phone to determine eligibility.
Participants	423 daily cigarette smokers randomized to 2 groups. Had been smoking for at least 1 year, aged between 18 and 67, smoking 10+ CPD, and not using any other type of tobacco. 44% F, av. age 43.4.
Interventions	1. LifeSign- Nicotine nasal spray (NNS): provided with handheld computer which decreased the use of cigarettes and increased the use of nicotine nasal spray over 10 days. Ps were then expected to quit smoking and use the nasal spray only. After 3 weeks of NNS use the program decreased usage. 2. Nicotine nasal spray only: participants instructed to set a quit date , quit smoking and begin using NNS as instructed on packet. Pharmacotherapy: Nicotine nasal spray was used pre and post quit in LifeSign-NNS arm and only post quit in the NNS only arm. Type of support: Self-help- minimal contact with little/no behavioural support.
Outcomes	Abstinence: 7 day PP at 12 month follow-up (PP at 5 weeks (mid-treatment), 10 weeks (EOT) & 6 m also reported) Validation: CO $\leq$8 ppm at 10 weeks (EOT), 6 & 12 month follow-ups. Other outcomes: CPD, nasal spray use, reasons for ceasing nasal spray use.
Notes	

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Randomized, method not described.
Allocation concealment?	Yes	Self-help intervention involving minimal contact with investigators/enrolling clinicians, risk of bias assessed as low.
Incomplete outcome data addressed? All outcomes	Unclear	Loss to follow-up was 43% at 6 months, and 57% at 12 months. This data wasn't split by groups so no comparison of loss to follow-up between groups could be carried out. Analysis was carried out as intention to treat.

Roales-Nieto 1992

Methods	Country: Spain Recruitment: students voluntarily responded in answer to announcements made in diverse academic centres of the university and through people who upon learning of the study suggested participation to relatives or friends.
Participants	23 participants took part and chose the goal of abstinence or reduction (controlled smoking), within each goal these participants were then randomized. 14 participants chose abstinence as their goal, and were randomized into 2 groups. Had been smoking for at least 5 years, and smoking 15+ CPD.
Interventions	1. Reduction (with goal of abstinence): received instructions to reduce cigarette consumption over 4 weeks (25% week 1, 50% week 2, 75% week 3, abstinence week 4) 2. Abrupt quitting (with goal of abstinence): received instructions to stop smoking completely on the first day of treatment 3. Reduction (with goal of controlled smoking): participants set reduction goal and received instructions to reduce their consumption to this goal. 4. Abrupt quitting (with goal of controlled smoking): participants set reduction goal and were asked to abruptly drop to this goal consumption Pharmacotherapy: No pharmacotherapy. Type of support: Behavioural.
Outcomes	Abstinence: 1 week PP at 1 year follow-up (also reported at EOT, 3 month, 6 month, 9 month and. Validation: for some participants a verifier they didn't know about was also asked to report CPD. Participant and verifier ratings corresponded in all cases. Other outcomes: Smoking rates at baseline and follow-ups, treatment compliance.
Notes	Only groups 1 and 2 are of interest and included in this meta-analysis as we are only interested in interventions with a goal to quit.

Risk of bias

Item	**Authors' judgement**	**Description**
Adequate sequence generation?	Unclear	Randomized, method not described.
Allocation concealment?	Unclear	No information given.
Incomplete outcome data addressed? All outcomes	Yes	All bar one participant, were followed up for the whole year. Therefore loss to follow-up was 14.3% in the abrupt group and 0% in the reduction group at 12 months. This is a small loss to follow-up, however there were only 14 participants randomized and these were all students at the University where the research took place, and so were potentially easy to follow-up.

CPD - cigarettes per day
EOT - end of treatment
PP - point prevalence abstinence

Characteristics of excluded studies *[ordered by study ID]*

Bernard 1972	All study arms reduced- two with a goal of quitting, one with a goal of controlled smoking.
Bolliger 2000a	The CEASE trial included participants who were all asked to quit in the same way (with NRT or placebo).
Bolliger 2000b	The Rossette study included participants who were all asked to reduce with a goal of controlled smoking in the same way (with NRT or placebo).
Bullen 2008	There was no reduction arm. Both arms were asked to smoke as they wished before quitting.
Cinciripini 1994	The control group was not an abrupt quit intervention. Participants received a complete 'I Quit Kit' (American Cancer Society,1977), which included a 7-day smoking reduction schedule.
Daughton 1998	All participants quit in the same way, either using nicotine patches or placebo patches.
Glasgow 1989	Reduction occurred in both trial arms. The key difference between arms was post-quit.
Hatsukami 1988	The reduction arm had a goal of reduced controlled smoking rather than quitting smoking.
Herrara 1995	All groups reduced using nicotine gum or placebo gum.
Jerome & Fiero 1999	Reduced scheduling was with regard to nicotine gum use. Both arms quit abruptly before beginning to use the nicotine gum.
Marston 1971	Main outcome was smoking rates. Abstinence rates were not reported and not possible to calculate from reported results.
Rezaishiraz 2007	Participants were asked to restrict themselves to one pack of reduced nicotine cigarettes per day during the 2 weeks pre-quit. However this instruction was given to both study arms.
Rose 1998	Neither arm was asked to reduce before quitting.
Rose 2006	Neither arm was asked to reduce before quitting.
Rose 2009	Neither arm was asked to reduce before quitting.
Schuurmans 2004	Neither arm was asked to reduce before quitting.
Shiffman 2009	Neither arm quit abruptly. Both study arms reduced before quitting.

Characteristics of ongoing studies *[ordered by study ID]*

Cinciripini 2006

Trial name or title	Scheduled smoking with transdermal nicotine.
Methods	Country: USA Recruitment: from the community. Randomization: method not stated.
Participants	Over 700 daily smokers randomized to 3 groups.
Interventions	1. SSNP: scheduled smoking with concurrent transdermal nicotine replacement. Smoking scheduled using a hand-held computer, which signals smoking at progressively increasing inter-cigarette intervals. 2. SS: scheduled smoking alone plus nicotine replacement therapy post-quit. Smoking scheduled using a hand-held computer, which signals smoking at progressively increasing inter-cigarette intervals. 3. UCC: usual care control, instructed to quit smoking within a few days of study entry and begin using the nicotine patch on their quit day. They are provided with no instructions to reduce and monitor their smoking behaviour using a hand-held computer. Pharmacotherapy: Transdermal nicotine patch in all groups. Both pre and post quit in SSNP group and only post-quit in SS and UCC groups. Type of support: Self-help materials
Outcomes	Abstinence: at 4 weeks post quit, long-term quit rates (no further detail known). Validation: Unknown Other outcomes: Unknown
Starting date	01/04/1998
Contact information	Dr Cinciripini, Director Tobacco Treatment Program and Deputy Chair University of Texas MD Anderson Cancer Center Department of Behavioral Science-Unit 1330 PO Box 301439, Houston Texas [pcinciri@mdanderson.org]
Notes	Data analysis is currently being carried out for this study.

Lindson 2009

Trial name or title	Rapid Reduction Trial.
Methods	Country: UK Recruitment: General practitioner's practices and NHS Stop Smoking Services write to patients recorded as smokers and offer them treatment. Randomization: Stata used to accomplish stratified randomization by therapist with blocking within each stratum. The blocks are randomly ordered blocks of 2, 4, and 6. Each therapist opens sealed numbered envelopes in turn to determine allocation to abrupt cessation or rapid reduction.
Participants	700 participants randomized to two arms. Males and females 18 years+, smoking at least 15 cigarettes or 12.5 grams of loose tobacco daily as roll your own cigarettes, or blows 15 parts per million or above on exhaled

Lindson 2009 (*Continued*)

	carbon monoxide (CO) reading, willing to stop smoking completely in two weeks.
Interventions	1. Abrupt cessation arm: participants instructed to smoke as normal for two weeks before quitting abruptly on a designated quit day. 2. Rapid reduction arm: participants instructed to reduce their smoking over to weeks and then quit completely on a designated quit day. Participants choose from one of three reduction methods: 1) Scheduled reduction- time between cigarettes gradually increased so smoking 50% of baseline end of week 1, and 25% end of week 2, 2) Hierarchical reduction- cigarettes usually smoked identified and eliminated, hardest or easiest first, until smoking 50% of baseline end of week 1, and 25% end of week 2, 3) Smoke-free periods- participants reduce the number of time periods in which they usually smoke by 50% in week 1 and by a further 50% in week 2. Pharmacotherapy: nicotine patches used in both arms pre- and post-quit. Acute NRT (type chosen by participant) used pre- and post-quit in reduction arm and post-quit only in the abrupt arm. Type of support: Behavioural support weekly from 2 weeks pre-quit to 4 weeks post-quit.
Outcomes	Abstinence: PP and prolonged at 4 weeks, 8 weeks and 6 months post quit Validation: Exhaled carbon monoxide Other outcomes: Cotinine levels pre-quit and 1 week post-quit, cigarette reward, urges to smoke, withdrawal, confidence in quitting, smoking stereotypy.
Starting date	01/01/2009
Contact information	Nicola Lindson (nll839@bham.ac.uk), Paul Aveyard (p.n.aveyard@bham.ac.uk) at: Primary Care Clinical Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK
Notes	This study is in the participant recruitment and data collection stages and aims to be completed by 31/12/2012.

Riley 2001

Trial name or title	Combining scheduled reduction with nicotine replacement.
Methods	Country: USA Recruitment: through television media advertising. Randomization: method not stated
Participants	337 smokers desiring to quit randomized to 2 conditions. Aged between 18 and 65, had been smoking over 15 CPD for at least 1 year, no current nicotine product use, no Zyban or other antidepressant use for over 1 month, no medical condition which would preclude the use of the nicotine patch. 44% F, av.age 41, av. CPD 24.4, av. 3.2 previous quit attempts.
Interventions	1. Computerised scheduled gradual reduction + patch: a handheld computer was used to schedule the reduction of smoking rate by increasing the interval between smoking of cigarettes. When smoking rate was down to 10 CPD participants were advised to stop smoking completely and start the use of nicotine patches. 2. Patch only: participants advised to stop smoking abruptly, with no reduction, and then begin using nicotine patch. Pharmacotherapy: nicotine patches were used in both arms post-quit. Type of support: Self-help- minimal contact with little/no behavioural support.

Riley 2001 (*Continued*)

Outcomes	Abstinence: 7 day pp and continuous abstinence at EOT (12 weeks post study entry), unknown at 6 & 12 month follow-up. Validation: CO at EOT, unknown at 6 & 12 month follow-ups. Other outcomes: time to relapse, patch use, satisfaction with patch, computer program use.
Starting date	01/05/1997
Contact information	Dr Riley, NHLBI [William.Riley@nih.gov]
Notes	Data analysis is currently being carried out on 6 & 12 month follow-up data for this study.

DATA AND ANALYSES

Comparison 1. Reduction to quit versus abrupt quitting

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Abstinence: Main analysis	10	3760	Risk Ratio (M-H, Fixed, 95% CI)	0.94 [0.79, 1.13]
2 Abstinence: Sub-group analysis split by use of pharmacotherapy	10	3760	Risk Ratio (M-H, Fixed, 95% CI)	0.94 [0.79, 1.13]
2.1 Pharmacotherapy (NRT) used	3	1333	Risk Ratio (M-H, Fixed, 95% CI)	0.89 [0.65, 1.22]
2.2 No pharmacotherapy used	7	2427	Risk Ratio (M-H, Fixed, 95% CI)	0.97 [0.78, 1.21]
3 Abstinence: Sub-group analysis split by type of behavioural support	10	3760	Risk Ratio (M-H, Fixed, 95% CI)	0.94 [0.78, 1.13]
3.1 Self-help therapy	5	2816	Risk Ratio (M-H, Fixed, 95% CI)	0.98 [0.78, 1.23]
3.2 Behavioural support	6	944	Risk Ratio (M-H, Fixed, 95% CI)	0.87 [0.64, 1.17]

Analysis 1.1. Comparison 1 Reduction to quit versus abrupt quitting, Outcome 1 Abstinence: Main analysis.

Review: Reduction versus abrupt cessation in smokers who want to quit

Comparison: 1 Reduction to quit versus abrupt quitting

Outcome: 1 Abstinence: Main analysis

Study or subgroup	Reduction to quit n/N	Abrupt quitting n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Flaxman 1978	9/32	9/16		5.9 %	0.50 [0.25, 1.01]
Hughes 2009	12/297	21/299		10.3 %	0.58 [0.29, 1.15]
Jerome 1999	43/415	39/296		22.5 %	0.79 [0.52, 1.18]
Gunther 1992	12/55	14/55		6.9 %	0.86 [0.44, 1.68]
Riley 2005	21/227	19/196		10.1 %	0.95 [0.53, 1.72]
Curry 1988	16/65	19/74		8.8 %	0.96 [0.54, 1.70]
Etter 2009	32/154	31/160		15.0 %	1.07 [0.69, 1.67]
Cinciripini 1995	20/65	17/63		8.5 %	1.14 [0.66, 1.97]
Cummings 1988	35/662	23/615		11.8 %	1.41 [0.85, 2.36]

(*Continued* . . .)

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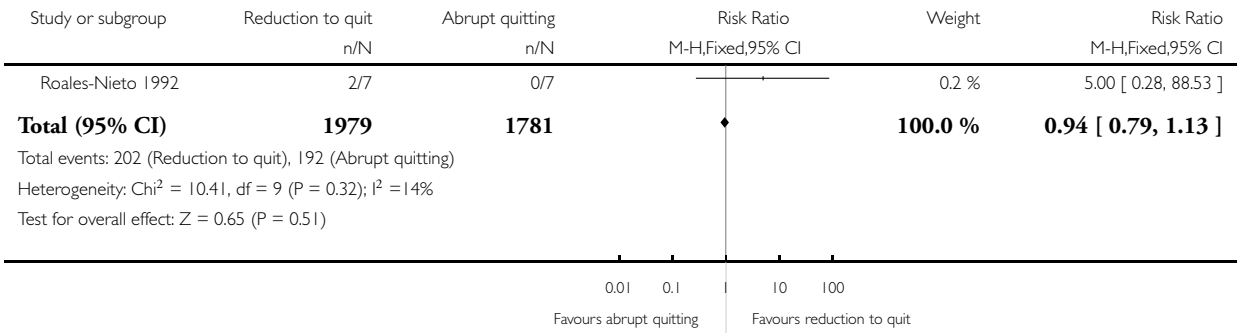
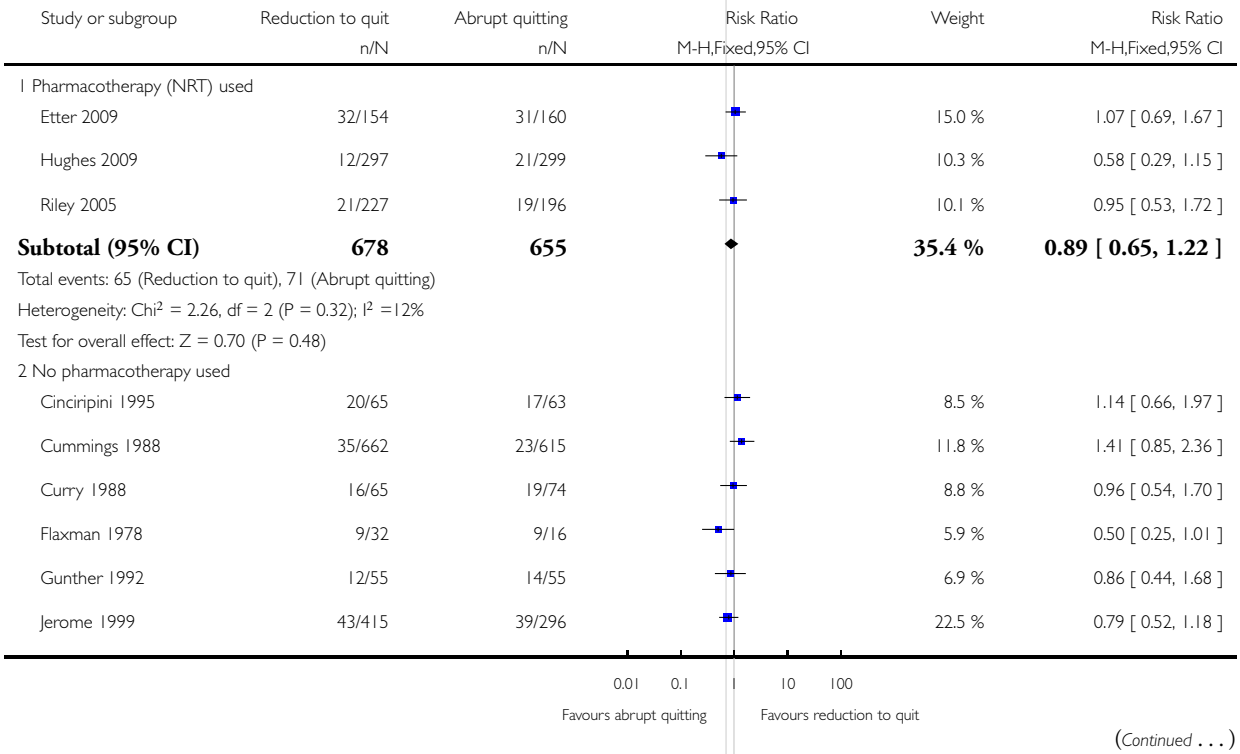


Analysis 1.2. Comparison 1 Reduction to quit versus abrupt quitting, Outcome 2 Abstinence: Sub-group analysis split by use of pharmacotherapy.

Review: Reduction versus abrupt cessation in smokers who want to quit

Comparison: 1 Reduction to quit versus abrupt quitting

Outcome: 2 Abstinence: Sub-group analysis split by use of pharmacotherapy



(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Reduction to quit n/N	Abrupt quitting n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Roales-Nieto 1992	2/7	0/7		0.2 %	5.00 [0.28, 88.53]
Subtotal (95% CI)	**1301**	**1126**		**64.6 %**	**0.97 [0.78, 1.21]**
Total events: 137 (Reduction to quit), 121 (Abrupt quitting)					
Heterogeneity: Chi^2 = 8.21, df = 6 (P = 0.22); I^2 =27%					
Test for overall effect: Z = 0.29 (P = 0.77)					
Total (95% CI)	**1979**	**1781**		**100.0 %**	**0.94 [0.79, 1.13]**
Total events: 202 (Reduction to quit), 192 (Abrupt quitting)					
Heterogeneity: Chi^2 = 10.41, df = 9 (P = 0.32); I^2 =14%					
Test for overall effect: Z = 0.65 (P = 0.51)					

Analysis 1.3. Comparison 1 Reduction to quit versus abrupt quitting, Outcome 3 Abstinence: Sub-group analysis split by type of behavioural support.

Review: Reduction versus abrupt cessation in smokers who want to quit

Comparison: 1 Reduction to quit versus abrupt quitting

Outcome: 3 Abstinence: Sub-group analysis split by type of behavioural support

Study or subgroup	Reduction to quit n/N	Abrupt quitting n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
1 Self-help therapy					
Cummings 1988	35/662	23/615		11.8 %	1.41 [0.85, 2.36]
Curry 1988	7/41	13/50		5.8 %	0.66 [0.29, 1.49]
Etter 2009	32/154	31/160		15.0 %	1.07 [0.69, 1.67]
Jerome 1999	43/415	39/296		22.5 %	0.79 [0.52, 1.18]
Riley 2005	21/227	19/196		10.1 %	0.95 [0.53, 1.72]
Subtotal (95% CI)	**1499**	**1317**		**65.1 %**	**0.98 [0.78, 1.23]**
Total events: 138 (Reduction to quit), 125 (Abrupt quitting)					
Heterogeneity: Chi^2 = 4.15, df = 4 (P = 0.39); I^2 =4%					
Test for overall effect: Z = 0.17 (P = 0.86)					
2 Behavioural support					
Cinciripini 1995	20/65	17/63		8.5 %	1.14 [0.66, 1.97]

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Reduction to quit n/N	Abrupt quitting n/N	Risk Ratio M-H,Fixed,95% CI	Weight	Risk Ratio M-H,Fixed,95% CI
Curry 1988	9/24	6/24		3.0 %	1.50 [0.63, 3.56]
Flaxman 1978	9/32	9/16		5.9 %	0.50 [0.25, 1.01]
Gunther 1992	12/55	14/55		6.9 %	0.86 [0.44, 1.68]
Hughes 2009	12/297	21/299		10.3 %	0.58 [0.29, 1.15]
Roales-Nieto 1992	2/7	0/7		0.2 %	5.00 [0.28, 88.53]
Subtotal (95% CI)	**480**	**464**		**34.9 %**	**0.87 [0.64, 1.17]**
Total events: 64 (Reduction to quit), 67 (Abrupt quitting)					
Heterogeneity: Chi^2 = 7.65, df = 5 (P = 0.18); I^2 =35%					
Test for overall effect: Z = 0.95 (P = 0.34)					
Total (95% CI)	**1979**	**1781**		**100.0 %**	**0.94 [0.78, 1.13]**
Total events: 202 (Reduction to quit), 192 (Abrupt quitting)					
Heterogeneity: Chi^2 = 12.25, df = 10 (P = 0.27); I^2 =18%					
Test for overall effect: Z = 0.67 (P = 0.50)					

APPENDICES

Appendix 1. MEDLINE search strategy

1 cold turkey.mp
2 (schedul* adj3 smok*).mp
3 (cut* down or cut-down).mp
4 (({Gradual* or abrupt*}) adj3 (reduction or reduce* or quit* or stop* or abstin* or abstain* or cessat*)).mp
5 fading.mp
6 taper*.mp
7 controlled smoking.mp
8 1 or 2 or 3 or 4 or 5 or 6 or 7
9 RANDOMIZED-CONTROLLED-TRIAL.pt
10 CONTROLLED-CLINICAL-TRIAL.pt
11 CLINICAL-TRIAL.pt
12 Meta analysis.pt
13 exp Clinical Trial/
14 Random-Allocation/
15 randomized-controlled trials/
16 double-blind-method/
17 single-blind-method/
18 placebos/
19 Research-Design/
20 ((clin$ adj5 trial$) or placebo$ or random$).ti,ab.

21 ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask$)).ti,ab.
22 (volunteer$ or prospectiv$).ti,ab.
23 exp Follow-Up-Studies/
24 exp Retrospective-Studies/
25 exp Prospective-Studies/
26 exp Evaluation-Studies/ or Program-Evaluation.mp.
27 exp Cross-Sectional-Studies/
28 exp Behavior-therapy/
29 exp Health-Promotion/
30 exp Community-Health-Services/
31 exp Health-Education/
32 exp Health-Behavior/
33 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32
34 smoking cessation.mp. or exp Smoking Cessation/
35 "Tobacco-Use-Cessation"/
36 "Tobacco-Use-Disorder"/
37 Tobacco-Smokeless/
38 exp Tobacco-Smoke-Pollution/
39 exp Tobacco-/
40 exp Nicotine-/
41 ((quit$ or stop$ or ceas$ or giv$) adj5 smoking).ti,ab.
42 exp Smoking/pc, th
43 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42
44 9 or 10 or 11 [RCTs, CCTs, Clinical trials]
45 33 and 43 [A category smoking+all design terms]
46 (animals not humans).sh. [used with 'not' to exclude animal studies for each subset]
47 (44 or REVIEW.pt.) and 43 [A category smoking+core trial terms or review]
48 47 not 46 [A category smoking+core trial terms, human]
49 45 not 47 [A category smoking excluding core trials]
50 45 not 47 not 46 [A category smoking excluding core trials, human]
51 exp Smoking/
52 33 and 51 [B category smoking+all design terms]
53 52 not 45 [B not A]
54 53 and 44 [B core trials]
55 (53 and 44) not 46
56 53 not 54 [B excluding core trials]
57 53 not 54 not 46
58 57 [B not CTS]
59 55 [B likely CTS]
60 50 [A not CTS]
61 48 [A likely CTS]
62 59 or 61
63 8 and 62
64 60 or 58
65 8 and 64
66 63 or 65

Appendix 2. PsycINFO search strategy

1 cold turkey.mp [mp=title, abstract, heading word, table of contents, key concepts]
2 (schedul* adj3 smok*).mp
3 (cut* down or cut-down).mp
4 (({Gradual* or abrupt*}) adj3 (reduction or reduce* or quit* or stop* or abstin* or abstain* or cessat*)).mp
5 fading.mp
6 taper*.mp
7 controlled smoking.mp
8 smoking cessation.mp. or exp Smoking Cessation/
9 (antismoking or anti-smoking).mp.
10 (quit$ or cessat$).mp
11 (abstin$ or abstain$).mp
12 (control adj smok$).mp
13 exp behavior modification/
14 9 or 10 or 11 or 12 or 13
15 tobacco-smoking/
16 (smok$ or cigar$ or tobacco$).mp.
17 Prevention/
18 15 or 16
19 14 and 18
20 17 and 18
21 8 or 19 or 20
22 6 or 4 or 1 or 3 or 7 or 2 or 5
23 22 and 21

Appendix 3. EMBASE search strategy

1 cold turkey.mp [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
2 (schedul* adj3 smok*).mp
3 (cut* down or cut-down).mp
4 (({Gradual* or abrupt*}) adj3 (reduction or reduce* or quit* or stop* or abstin* or abstain* or cessat*))
5 fading.mp
6 taper*.mp
7 controlled smoking.mp
8 1 or 2 or 3 or 4 or 5 or 6 or 7
9 random$.ti,ab
10 factorial$.ti,ab
11 (cross over$ or crossover$ or cross-over$).ti,ab
12 placebo$.ti,ab
13 (double$ adj blind$).ti,ab
14 (single$ adj blind$).ti,ab
15 assign$.ti,ab
16 allocat$.ti,ab
17 volunteer$.ti,ab
18 CROSSOVER PROCEDURE.sh
19 DOUBLE-BLIND PROCEDURE.sh
20 RANDOMIZED CONTROLLED TRIAL.sh
21 SINGLE-BLIND PROCEDURE.sh
22 or/9-21
23 smoking cessation.mp
24 exp smoking cessation/

25 exp smoking-/
26 ((quit$ or stop$ or ceas$ or giv$ or prevent$) adj smok$).mp
27 exp passive smoking/
28 exp smoking habit/
29 exp cigarette smoking/
30 or/23-29
31 22 and 30
32 8 and 31

HISTORY

Protocol first published: Issue 4, 2009

Review first published: Issue 3, 2010

CONTRIBUTIONS OF AUTHORS

NL & PA checked references against eligibility criteria and extracted data and any disagreements were resolved through discussion with JH. NL drafted the review, with review and contributions from PA & JH.

DECLARATIONS OF INTEREST

Dr Aveyard has done consultancy work for Pfizer, McNeil, and Xenova/Celtic who make products for smoking cessation.

Dr Hughes is currently employed by The University of Vermont and Fletcher Allen Health Care. He has also received grants and consulting fees from many for-profit and non-profit companies that market smoking cessation products and services. He is an author of one trial included in this review.

SOURCES OF SUPPORT

Internal sources

- Paul Aveyard, UK.

Paul Aveyard receives a salary part-funded by the University of Birmingham

- John Hughes, USA.

John Hughes receives a salary part-funded by the University of Vermont

External sources

- Paul Aveyard, UK.

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- Nicola Lindson, UK.

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- John Hughes, USA.

John Hughes' salary is part-funded by Fletcher Allen Health Care

INDEX TERMS

Medical Subject Headings (MeSH)

Randomized Controlled Trials as Topic; Smoking [psychology; *therapy]; Smoking Cessation [*methods; psychology]

MeSH check words

Adult; Humans